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MUSSELS OF THE EAST FORK OF THE TOMBIGBEE RIVER, MONROE AND ITAWAMBA COUNTIES, MISSISSIPPI

by

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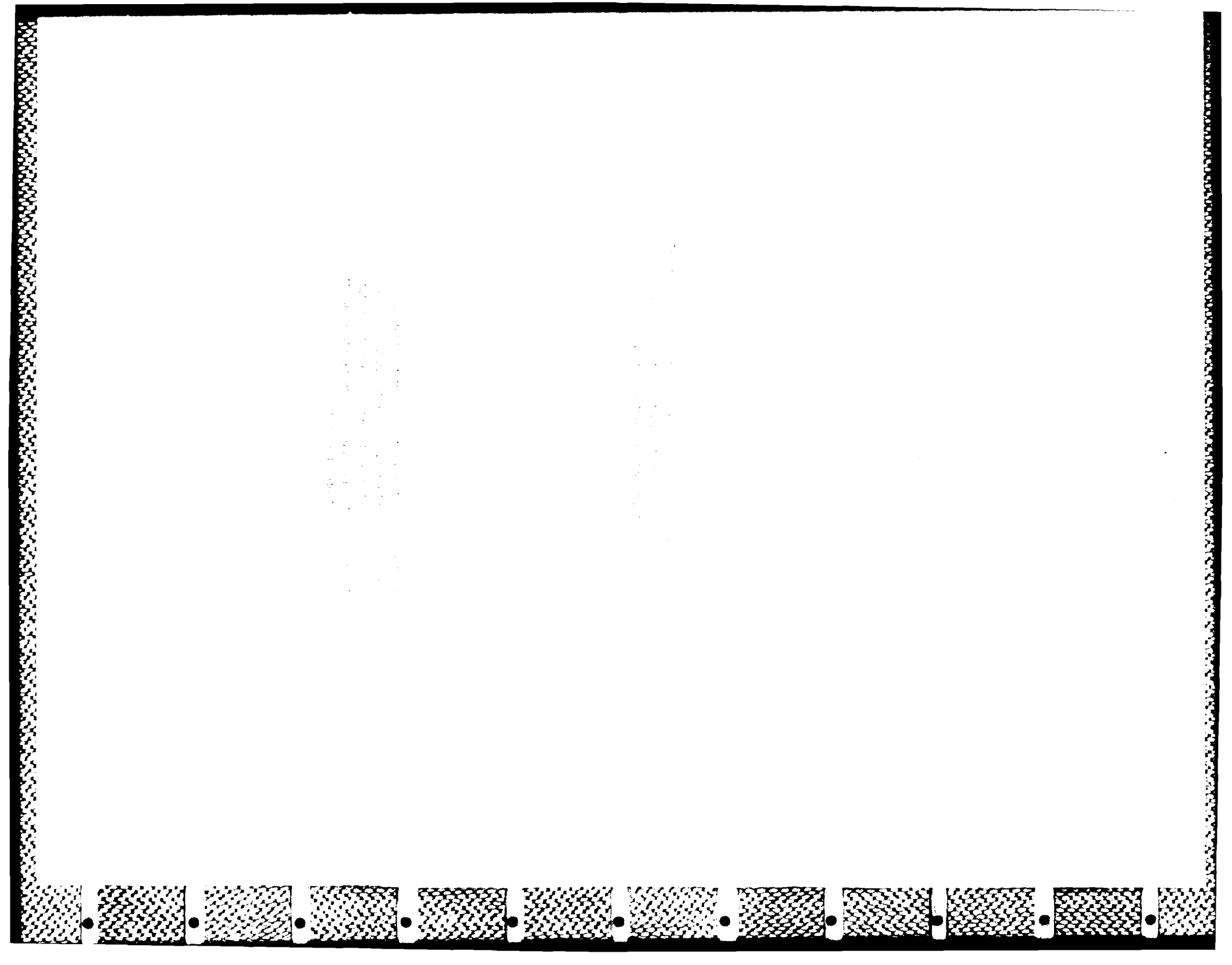

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Twenty-eight species of mussels, in addition to the exotic Asiatic clam *Corbicula fluminea*, were collected in nine reaches of the East Fork of the Tombigbee River, Monroe and Itawamba Counties, Mississippi, in September 1987. Seventeen species, including *C. fluminea*, were collected alive, and 12 species were found only as shells. Evidence of recent recruitment was found for 19 species. The substratum in the upper reaches consisted of sand and mud, species richness and numbers of mussels were reduced, and the fauna was dominated by *Leptodea fragilis* and *Lampsilis teres*. The mid and lower reaches were characterized by pool-riffle sequences, exposed gravel shoals, and a rich fauna dominated by *Amblema plicata* and *Megalonaias gigantea*. A fresh shell of *Epioblasma penita*, listed as endangered by the US Fish and Wildlife Service, was found near the confluence of Bull Mountain Creek. Although this river provided excellent mussel habitat, settled sediments and reduced flows had negatively affected some of the fauna in the mid and lower reaches.

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PREFACE

In September 1987, freshwater mussels (Mollusca:Unionidae) were collected in the East Fork of the Tombigbee River, Monroe and Itawamba Counties, Mississippi. The US Army Engineer District, Mobile (SAM), Mobile, AL, will use this information to evaluate the effects of various proposed water management measures on the freshwater mussels. This report was prepared by Dr. Andrew C. Miller, US Army Engineer Waterways Experiment Station (WES), and Mr. Paul D. Hartfield, Curator of Invertebrates, Mississippi Museum of Natural Science, Jackson, MS. The report was edited by Ms. Lee T. Byrne of the WES Information Products Division, Information Technology Laboratory.

Mr. Edwin A. Theriot was Chief, Aquatic Habitat Group; Dr. Conrad J. Kirby was Chief, Environmental Resources Division; and Dr. John Harrison was Chief, Environmental Laboratory, WES, during the conduct of this study.

Commander and Director of WES was COL Dwayne G. Lee, CE. Technical Director was Dr. Robert W. Whalin.

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CONTENTS

MUSSELS OF THE EAST FORK OF THE TOMBIGBEE RIVER, MONROE AND ITAWAMBA COUNTIES, MISSISSIPPI

PART I: INTRODUCTION

Background

1. Freshwater mussels are a renewable resource with economic, cultural, and ecological value. Native Americans collected mussels for food and used their shells as ornaments. Before the development of plastics, pearl buttons were made from the shells of many species. Today, shells of certain species (i.e. *Amblema plicata* and *Megalonaias gigantea*) are processed into spheres that are inserted into oysters to make cultured pearls. Because they are long-lived and practically nonmotile, their presence at a site provides evidence of previous habitat conditions. Freshwater mussels can be used for bioassay studies and research on sublethal and lethal stress. Thirty species of mussels are now listed as endangered in North America (US Fish and Wildlife Service (USFWS) 1987). Five of these are restricted to the Tombigbee watershed in eastern Mississippi and western Alabama.

2. Freshwater mussels are found in streams, rivers, ponds, and lakes. Frequently they dominate the benthic fauna, both in numbers and biomass. They inhabit a variety of substrata including mud, silt, sand, and gravel, or they can be found between and under large rocks. Most thick-shelled species (*A. plicata, M. gigantea, Quadrula* spp., and *Elliptio* spp.) are usually found in gravel bars in medium- to large-sized rivers. Thin-shelled species (*Anodonta* spp.) are most frequently collected in finer grained sediments in ponds, lakes, or sloughs. Although mussels can tolerate brief periods of desiccation, turbidity, and reduced oxygen, they require reasonably stable water levels and firm substratum that is free of rapid and excessive sedimentation.

3. The immature forms of most mussels (glochidea) are obligate parasites on the gill filaments, fins, or body surface of fishes. Some mussels can use a large number of host species, whereas others appear to require a single fish. Fuller (1974) lists 15 species as hosts for *A. plicata*, although only the skipjack herring is a host for *Fusconaia ebena*. Because of their unusual reproductive strategy, mussel distribution and population structure are related to the presence and behavior of fishes.

Purpose and Scope

4. The purpose of this study was to collect freshwater mussels and shells (Mollusca:Unionidae) in the East Fork of the Tombigbee River between the Lock E Spillway Exit Channel and the Tennessee-Tombigbee Waterway. The US Army Engineer District (USAED), Mobile, Mobile, AL, will use this information to evaluate the effects of various proposed water management measures on the freshwater mussels. The East Fork of the Tombigbee River supports a diverse and dense mussel fauna and is within the range of *Epioblasma penita*, *Pleurobema curtum*, and *P. taitianum*, listed as endangered by the USFWS (1987).

PART II: STUDY AREA AND METHODS

Study Area

5. From its headwaters in Prentiss and Tishomingo Counties in northeast Mississippi, the Tombigbee River flows in a southeasterly direction into Alabama. It joins the Black Warrior River at Demopolis and then the Alabama River in southern Alabama to form the Mobile River (Figure 1). In December 1984, the Tennessee-Tombigbee Waterway, which connects the Tennessee and Tombigbee Rivers, became operational. The waterway, which includes 10 locks and dams and a canal, provides a shortened route between the central United States and the eastern gulf coast. The East Fork of the Tombigbee River originates at the confluence of Mackeys and Brown Creeks, near river mile (RM) 403 on the waterway (Figure 2b). It flows south through Itawamba and Monroe Counties and joins the waterway near Amory at RM 366.3 (Figure 2c).

6. The substratum in the lower portion of the river (between Highway 6 and Bull Mountain Creek) consists of pool-riffle habitat with coarse gravel (D_{50} = 10 mm*). Upstream of Bull Mountain Creek, the river is characterized by long runs and sediments consisting mainly of fine sands (D_{50} = 0.25 mm). Between 1929 and 1980, sediment accumulation at Fulton (the upper section of the river) was 5.3 ft (1.615 cm) (USAED, Mobile 1988). The section downriver of Bull Mountain Creek has experienced little or no sediment accumulation in the same period. Both sections of the river have been exposed to the same sediment inputs; the lower section of the river has a higher transport capability. The thalweg slopes of selected portions of the East Fork of the Tombigbee River are as follows: 2.38 ft/mile (45.3 cm/km) between Town Creek and Boguefala Creek, 1.44 ft/mile (27.4 cm/km) between Boguefala Creek and Bull Mountain Creek, 1.32 ft/mile (25.1 cm/km) between Bull Mountain Creek and Mantachie Creek, 1.72 ft/mile (32.8 cm/km) between Mantachie Creek and Highway 78, and 1.77 ft/mile (33.7 cm/km) between Highway 78 and Walkers Bridge Road (USAED, Mobile 1988).

7. Prior to completion of the Tennessee-Tombigbee Waterway, the 7-day Q_{10} at Fulton, MS (57 years of record) was 26 ft^3/sec (0.736 m^3/sec). The

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* The diameter of 50 percent of the material is less than 10 mm, and the diameter of 50 percent of the material is greater than 10 mm.

record 1-day low flow was 12 ft^3/sec (0.339 m^3/sec) and the record 7-day low flow was 15 ft^3/sec (0.425 m^3/sec). Flow is now augmented in the East Fork of the Tombigbee River by release structures located in the reservoirs of Locks A, B, D, and E. These structures (and the volume of water they are designed to release) are at Mackeys Creek (50 ft^3/sec, 1.416 m^3/sec), Red Bud Creek (20 ft^3/sec, 0.566 m^3/sec), Mud Creek (20 ft^3/sec, 0.566 m^3/sec), Bull Mountain Creek (100 ft^3/sec, 2.832 m^3/sec), and Turner Branch (20 ft^3/sec, 0.566 m^3/sec). It was intended that these structures should release approximately four times the 7-day Q_{10}. The release structures at Red Bud and Mud Creeks were not operating at the time of the survey. Mud Creek will be used when a channel is built to carry water to the East Fork of the Tombigbee River. As soon as the problems of clogging at Red Bud Creek have been solved, this structure will be operational (Figure 2a). Excess flow in the Tennessee-Tombigbee Waterway can also be shunted into the East Fork of the Tombigbee River via spillway structures located at Locks B and E.

Methods

8. A small boat with motor was used to traverse the study area. Shells were collected by two individuals at exposed gravel bars and along shorelines. Intensive searches for live mussels were conducted at sites where fresh shells were found. Live mussels were collected by hand in shallow water and by snorkeling in deeper water. Because visibility was usually less than 15 cm, live mussels were recognized mainly by touch. The survey was conducted on 2-4 and 9-11 September 1987.

9. Following completion of the survey, the river was divided into nine reaches (Figure 2). This was done to facilitate analysis of data and discussion of results. See Appendix A and Figures 3-6 for information on each river reach.

PART III: RESULTS AND DISCUSSION

Community Composition and Distribution

10. Approximately 50 species of mussels have been reported from the Tombigbee River (Hinkley 1906, van der Schalie 1939, Crossman et al. 1975, Williams 1982). At least 34 species have been collected in the East Fork between Town and Mill creeks (Schultz 1981, Stansbery 1983a) and are exhibited in the Mississippi Museum of Natural Science Mussel Collection, Jackson, MS. In 1974, J. D. Williams and Randall Grace found abundant mussels below but very few specimens above Mill Creek.* C. A. Schultz and M. Pierson found similar conditions in 1980.** Both Williams and Schultz described the upper reaches as very sandy, with little gravel and very few mussels. Paul D. Hartfield† noted similar conditions in 1984 and again in August 1986.

11. In addition to the exotic Asiatic clam *Corbicula fluminea*, 28 species of freshwater mussels were collected in the East Fork of the Tombigbee River during this survey (Table 1). Of these, 17 species were found alive, and 12 species were represented only as shells. Evidence of recent recruitment (i.e. presence of individuals with less than 30- to 40-cm total shell length) was found for 19 species. It should be noted that many of the species with no evidence of recent recruitment were also uncommon. It is less likely to find immature specimens of rare species as compared with abundant species. A recently dead *E. penita*, listed as endangered by the USFWS (1987), was found near the mouth of Bull Mountain Creek. This specimen was 68 mm long, and the valves were in good condition.

12. The greatest number of mussel species, considering live specimens and shells, was found in Reaches 1 to 6. From 11 to 14 species were collected in the lower three reaches, and from 16 to 22 species were collected in Reaches 4 to 6. These lower six reaches, characterized by moderate to steep gradient and exposed gravel shoals, provided the best habitat for freshwater

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* Personal Communication, 1987, J. D. Williams, US Fish and Wildlife Service, Washington, DC.

** Personal Communication, 1988, C. A. Schultz, Mississippi Department of Wildlife Conservation, Amory, MS.

† Unpublished information, 1986-87, Mississippi Department of Wildlife Conservation, Jackson, MS.

mussels. In Reach 7 two species were collected alive, and seven species were represented only by shells. In Reach 8 only two species of mussels were found, and in Reach 9 only *C. fluminea* (a nonnative bivalve) was collected.

13. Thick-shelled species (*Tritogonia verrucosa*, *Obliquaria reflexa*, and *Quadrula asperata*) were abundant to common in Reaches 1 to 6, the lower section of the river. *Megalonaias gigantea*, a thick-shelled species that is common in large rivers, was abundant only in Reaches 5 and 6. *Lampsilis ornata*, a moderately thick-shelled species, was common to abundant in the lower six reaches of the river. *Potamilus purpuratus*, which has a moderately thick shell and usually inhabits fine-grained sediments, was rare in the lower five reaches and uncommon in Reach 6. The most ubiquitous mussel in the river was *Lampsilis teres* (found in eight reaches), followed by *Leptodea fragilis* (found in seven reaches). These two species were the only live mussels collected in Reach 8, which was characterized by sand with little or no gravel. Both species have relatively thin shells and tolerate sand and fine-grained sediments. Thick-shelled species, such as those that were common to abundant in the lower river, are not usually common in fine-grained sediments (Parmalee 1967).

Endangered Species

14. Five species of mussels recently placed on the Federal List of Endangered Species (USFWS 1987) [*E. penita* (Conrad, 1834), *P. curtum* (Lea, 1859), *P. marshalli* (Frierson, 1927), *P. taitianum* (Lea, 1834), and *Quadrula stapes* (Lea, 1831)] occur in the Mobile Basin. An examination of historical records reveals that three of these five species have been reported from the East Fork of the Tombigbee River.

15. During 1974, J. D. Williams and Randall Grace collected one recently dead *E. penita* and three recently dead *P. curtum* from the East Fork of the Tombigbee River just above the Itawamba-Monroe county line (Reach 5). They also found one complete specimen and one valve of *P. curtum* about 1 km below the county line, and 17 recently dead *E. penita* approximately 2.5 km below the county line (Stansbery 1983a, 1983b). In 1980, C. A. Schultz and M. Pierson collected six recently dead *E. penita* and one *P. taitianum* at a gravel bar just above the Itawamba-Monroe county line (Schultz 1981).

16. In 1984, Paul D. Hartfield, J. D. Williams, and J. Stewart surveyed the river between the Itawamba-Monroe county line and the confluence of Mill Creek. No endangered mussels were found. In 1986, P. Hartfield surveyed between Smithville Landing and Mill Creek but did not find any endangered mussels. In the present survey, a single specimen of *E. penita* was collected in the vicinity of Bull Mountain Creek.

17. Based on the results of this survey and those of earlier workers, the East Fork of the Tombigbee River provides habitat for three species of endangered mussels. Endangered mussels have been collected in Reaches 5 and 6, between Bull Mountain Creek and the Lock B Spillway Exit Channel. It is difficult to estimate the total number of living endangered mussels in the East Fork of the Tombigbee River. However, the authors feel that finding a fresh shell of *E. penita* indicates that this species still exists in the river. Many endangered species are extremely uncommon (i.e. less than 1 percent of the community); therefore, it is not easy to find live specimens.

Condition of the Existing Mussel Fauna

18. Mussel distribution, abundance and species richness in a river is related to the physical conditions of the habitat. A variety of suitable habitat for mussels exists in the East Fork of the Tombigbee River below the mouth of Mill Creek (Reaches 1 to 6). Fresh shells were common along most of these reaches, and live mussels were locally abundant. Above Mill Creek (Reaches 7 to 8), sand and silt accumulations provide marginal habitat for mussels.

19. Many recently dead mussels were observed between Mill Creek and the Itawamba-Monroe county line (Reaches 5 and 6). The majority of these were adults of large species and were either in shallow water or along the margins of gravel bars. Estimated mortalities, based upon observations made during this and a previous survey in 1986, were between 50 and 90 percent (Paul D. Hartfield*). The probable cause of the high mortality in Reaches 5 and 6 is the cumulative effect of low water and sediment deposition. Rainfall in the basin has been lower than normal for the past 4 years. Annual precipitation

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* Unpublished information, Mississippi Department of Wildlife Conservation, op. cit.

was 50.3, 49.7, 48.3, and 42.8 in. (127.8, 126.2, 122.7, and 108.7 cm), for 1984-87, respectively, which is less than the 50-year average of 54.6 in. (138.7 cm) (USAED, Mobile 1988). Reduced water levels caused many mussels to be stranded on gravel bars and exposed to the drying effects of the atmosphere. As a result of the placement of the five minimum-flow release structures, low-flow augmentation in the East Fork of the Tombigbee River has alleviated the situation to some extent. The 1985 and 1986 21-day low flows were greater than that which historically had a 50-percent probability of nonexceedance. This has occurred despite lower than average rainfall. An examination of average annual precipitation for the period of record indicates that extended periods of drought occur at 10- to 15-year intervals in the basin.

20. Accumulations of sediment (5 to 25 cm) were found in deposition areas in Reaches 1, 2, 5, and 6. Sediment from channelized tributaries in the western section of the drainage has been entering the East Fork of the Tombigbee River since the early 1900s and has caused localized filling of the floodplain and channel. Typically, these sediments are flushed from gravel bars by periods of high flow. However, the lower than normal precipitation during the last 4 years has also reduced the incidence of high flows that typically flush gravel bars of recently settled sediments. An undetermined amount of mussel mortality could have resulted from deposition of these fine sediments in the lower river.

21. The Tennessee-Tombigbee Waterway will not appreciably affect the sedimentation process in the East Fork of the Tombigbee River. An exception is the reach between the Lock B Spillway Exit Channel and the mouth of Bull Mountain Creek (Reaches 5 and 6). Flood flows from Bull Mountain Creek that originally shaped and sized this channel have now decreased by about 15 percent at the peak. (Actually these flows have now been shifted about 5.4 miles (8.6 km) downstream and enter the East Fork of the Tombigbee River via the Lock B Spillway). Following many cycles of flooding and low flows, this decrease in flow downstream of Bull Mountain Creek will create a new channel configuration. The new channel will experience increased aggradation of sediments and a decrease in median grain size of settled particles (USAED, Mobile 1988).

Effects of Water Removal

22. Water removal for domestic and industrial purposes during normal low-water periods can expose freshwater mussels to the atmosphere and cause mortality. However, many species can survive extended periods of exposure (Simpson 1891; Frierson 1903, 1923; Strecker 1908; Isely 1914; Coker et al. 1921; Haas 1939; Matteson 1955; White 1979). Death of exposed mussels is not due to desiccation per se, but from the cessation of water currents through the mantle cavity needed for feeding, respiration, and excretion. Payne and Miller (in preparation) studied the effects of desiccation on three species of thick-shelled mussels. *Megalonaias gigantea*, *Q. pustulosa*, and *F. flava* experienced 12.3-, 5.8-, and 4.6-percent reductions in wet weight and mortalities of 58, 42, and 33 percent after being held for 21 days in dry sand. Incomplete shell closure by *M. gigantea* was responsible for its high water loss. *Quadrula pustulosa* formed a better seal than did the former species, and *F. ebena* had the most complete shell closure. Many thick-shelled riverine unionids are virtually immune to water loss when their shell valves are tightly sealed.

Recommendations

23. The following recommendations are made to assist in the protection of common and endangered freshwater mussels in the East Fork of the Tombigbee River.

Effects of water removal

24. Any proposed plans for water removal in the East Fork should take into account the need to protect freshwater mussels. Based upon the technical literature and experiments conducted by Payne and Miller (in preparation), it is estimated that a 21-day exposure period could cause substantial mortality (i.e., 33 to 58 percent) in thick-shelled mussels. During periods of low flow, any water removed from the East Fork of the Tombigbee River should be augmented by increasing flows at the Lock B and E Spillways.

Determining effects of increased sedimentation

25. At least four sediment ranges should be established in the section of the river between the Lock B Spillway and the mouth of Bull Mountain Creek.

These should be monitored annually, and changes in sediment depth should be correlated to discharge data.

Localized sedimentation

26. At each range, depth of recently deposited sediments should be measured. Samples should be collected to determine particle size distribution.

Augmenting flow from release structures at Locks E and B

27. Presently, excessive flow that is less than 1,000 ft^3/sec (28.3 m^3/sec) at Locks E and B is routinely shunted into the canal via existing bypass structures. If these moderate flows are not required in the waterway, it is recommended that they be passed into the East Fork of the Tombigbee River through the existing spillways.

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Table 1

Bivalves Collected from the East Fork of the Tombigbee River, Monroe and Itawamba Counties, Mississippi, September 1987

Species	Condition*	Recruitment**
Amblema plicata (Say, 1817)	L	Y
Arcidens confragosus (Say, 1829)	S	Y
Elliptio arctata (Conrad, 1834)	S	N
Elliptio crassidens crassidens (Lamarck, 1819)	L	N
Ellipsaria lineolata (Rafinesque, 1820)	S	Y
Epioblasma penita (Conrad, 1834)	S	N
Fusconaia cerina (Conrad, 1838)	L	Y
Fusconaia ebena (Lea, 1813)	S	N
Lampsilis ornata (Conrad, 1835)	L	Y
Lampsilis straminea claibornensis (Lea, 1834)	L	N
Lampsilis teres (Rafinesque, 1820)	L	Y
Lasmigona complanata (Barnes, 1823)	L	Y
Leptodea fragilis (Rafinesque, 1820)	L	Y
Ligumia recta (Lamarck, 1819)	S	N
Megalonaias gigantea (Rafinesque, 1820)	L	Y
Obliquaria reflexa (Rafinesque, 1820)	L	Y
Obovaria unicolor (Lea, 1845)	S	Y
Plectomerus dombeyanus (Valenciennes, 1833)	L	N
Pleurobema decisum (Lea, 1831)	S	N
Potamilus purpuratus (Lamarck, 1819)	S	Y
Quadrula asperata (Lea, 1861)	L	Y
Quadrula rumphiana (Lea, 1852)	L	Y
Strophitus subvexus (Conrad, 1834)	S	N
Toxolasma parvus (Barnes, 1823)	L	Y
Tritogonia verrucosa (Rafinesque, 1820)	L	Y
Truncilla donaciformis (Lea, 1828)	L	Y
Villosa lienosa (Conrad, 1834)	S	N
Villosa vibex (Conrad, 1834)	S	Y
Corbicula fluminea (Muller, 1774)	L	Y

Total species of bivalves = 29
Total species collected alive = 17
Total species exhibiting evidence of recent recruitment = 19

* Condition:
L = collected alive.
S = collected as shells only.

** Recruitment:
Y = evidence of recruitment.
N = no evidence of recruitment.

Table 2

Bivalves Collected Along Eight Reaches of the East Fork of the Tombigbee River and Mackeys Creek, Monroe and Itawamba Counties, Mississippi, September 1987

Species	River Reach*									Total Reaches
	1	2	3	4	5	6	7	8	9	
Amblema plicata	--	R	--	--	U	A+	U#	--	--	4
Arcidens confragosus	--	--	--	R	R	--	--	--	--	2
Elliptio arctata	--	--	--	--	--	R	--	--	--	1
Elliptio crassidens crassidens	--	--	--	--	R	C+	U#	--	--	3
Ellipsaria lineolata	--	--	--	--	U	U	--	--	--	2
Epioblasma penita	--	--	--	--	--	U	--	--	--	1
Fusconaia cerina	--	--	--	A	U	C+	U#	--	--	4
Fusconaia ebena	--	R	--	--	U	U	--	--	--	3
Lampsilis ornata	A+	C	A+	A+	A	C+	--	--	--	6
Lampsilis straminea claibornensis	--	--	--	--	R+	U	U#	--	--	3
Lampsilis teres	R	U	U	U	U	U	R+	U	--	8
Lasmigona complanata	R+	R	R	R+	C	U	--	--	--	6
Leptodea fragilis	C	--	U	U	C	C	R	U	--	7
Ligumia recta	--	R	--	--	--	--	--	--	--	1
Megalonaias gigantea	R+	--	--	--	A+	A+	--	--	--	3
Obliquaria reflexa	A	U	C	A+	C	A+	--	--	--	6
Obovaria unicolor	A	R	--	R	--	R	U#	--	--	5
Plectomerus dombeyanus	--	--	--	--	--	R+	--	--	--	1
Pleurobema decisum	--	--	--	--	--	R#	--	--	--	1
Potamilus purpuratus	R	R	R	R	R	U	--	--	--	6
Quadrula asperata	A+	C	A+	A+	C	A+	U#	--	--	7
Quadrula rumphiana	U+	U	R+	R+	C	C	--	--	--	6
Strophitus subvexus	--	--	--	R	--	--	--	--	--	1
Toxolasma parvus	R+	--	--	--	--	--	--	--	--	1
Tritogonia verrucosa	A+	C	A+	A	A+	A+	--	--	--	6
Truncilla donaciformis	R	--	A	R	R	R	--	--	--	5
Villosa lienosa	--	R	--	R	--	--	--	--	--	2
Villosa vibex	--	--	--	--	R	--	--	--	--	1
Corbicula fluminea	C+	C+	C+	C+	C+	C+	C+	C+	C+	9
Total species	14	14	11	16	20	23	9	3	1	
Total species collected alive	8	1	5	6	4	10	2	1	1	

Note: For shell collections: A = abundant, collected on most gravel bars in numbers greater than 10; C = common, collected at most gravel bars in numbers 5-10; U = uncommon, collected at most gravel bars in numbers less than 5; R = rare, one or two individuals collected occasionally; # = subfossil; and + = collected alive.

* River reaches:

1 US 278 to MS 6.
2 MS 6 to Standifer Creek.
3 Standifer Creek to Boguefala Creek.
4 Boguefala Creek to Lock B Spillway.
5 Lock B Spillway to Old Smithville Bridge.
6 Old Smithville Bridge to Mill Creek.
7 Mill Creek to old US 78 Bridge.
8 Old US 78 Bridge to Mackeys Creek.
9 Mackeys Creek to Lock E.

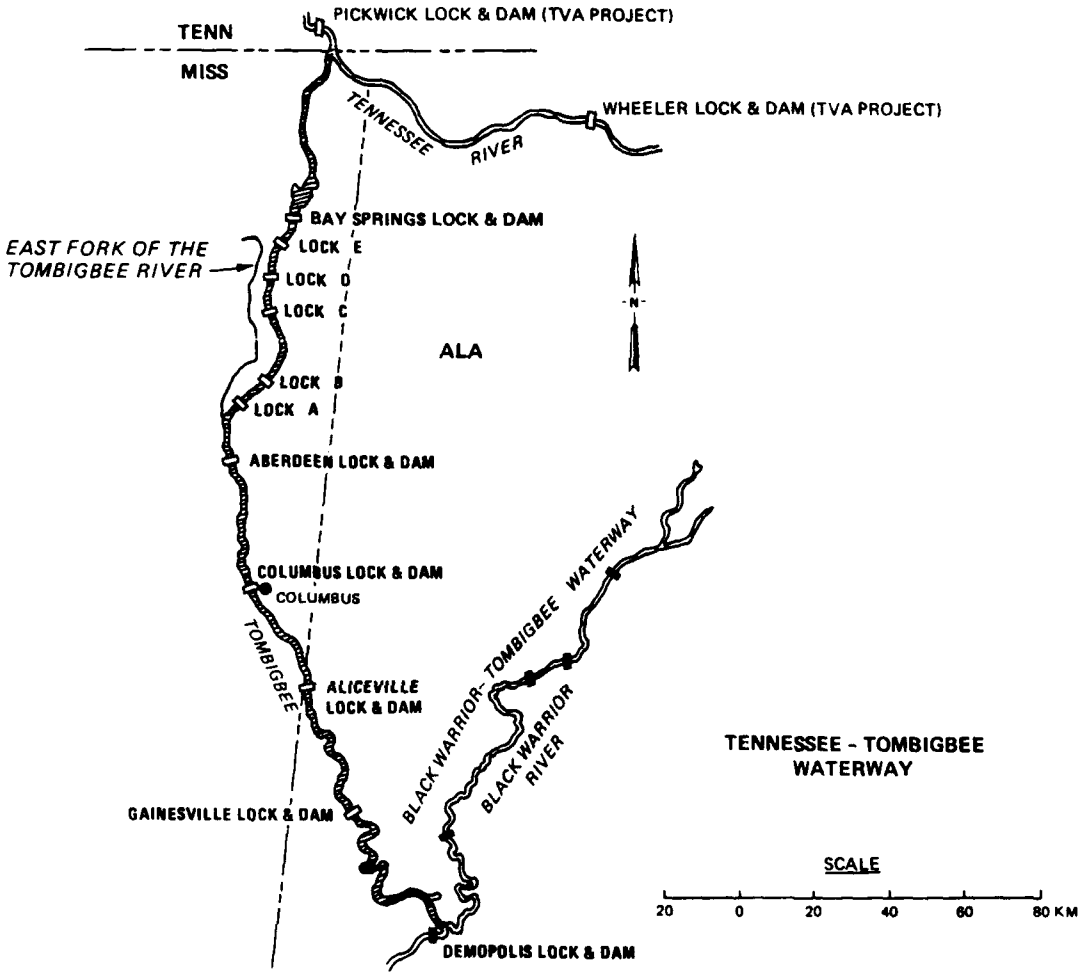
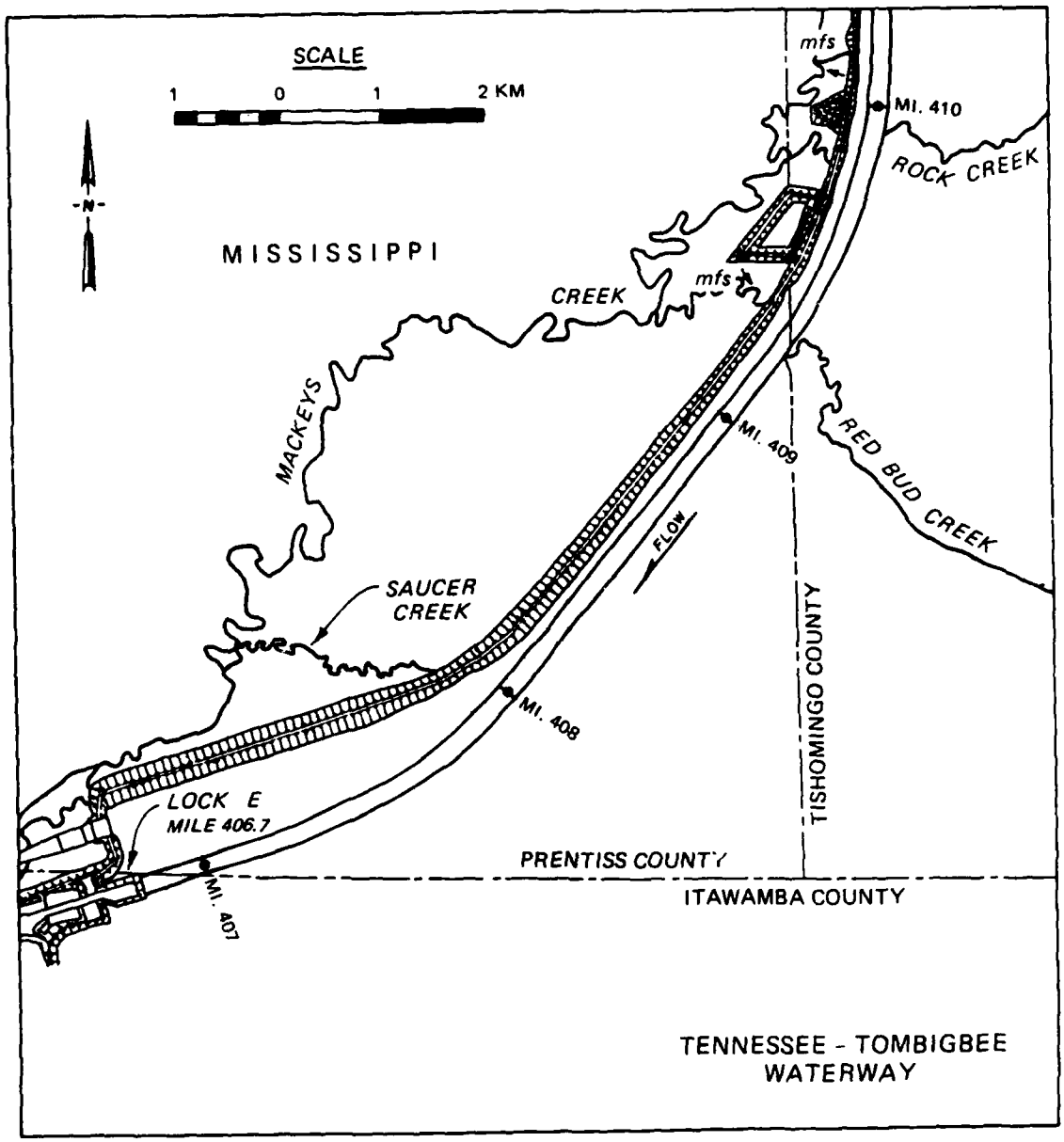
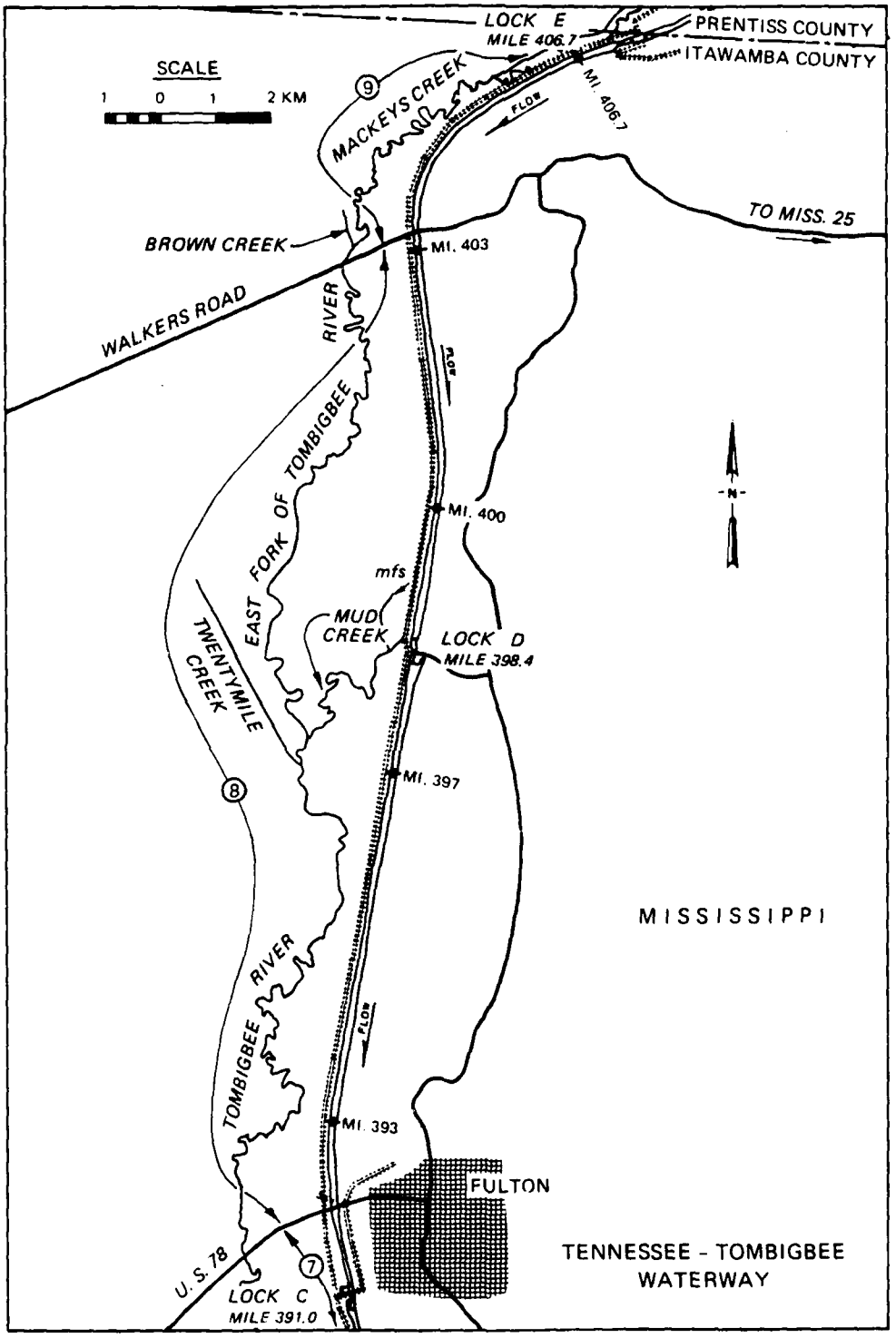


Figure 1. Vicinity map, East Fork of the Tombigbee River



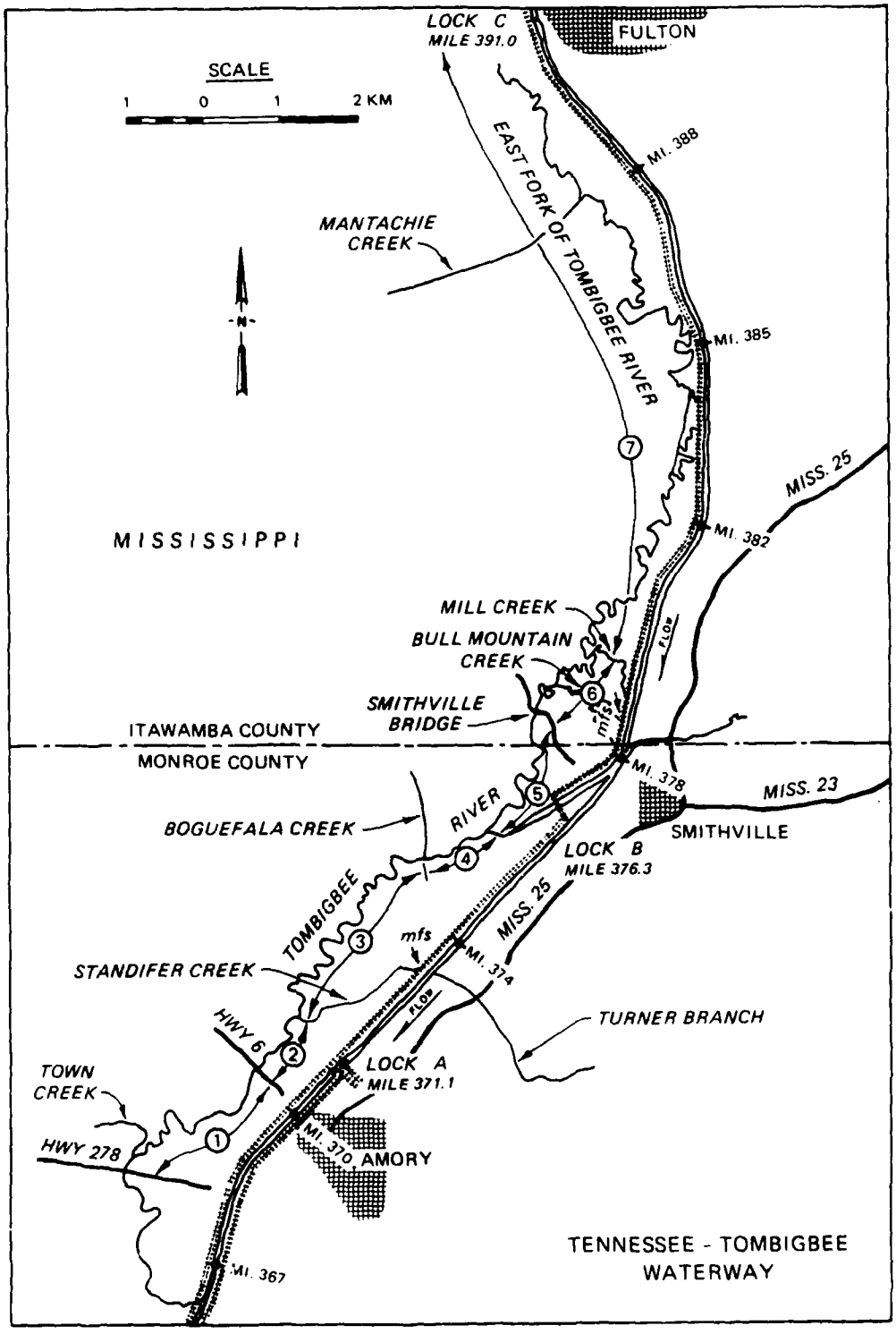
a. Pool E

Figure 2. Reaches searched for mussels on the East Fork of the Tombigbee River, Monroe and Itawamba Counties, Mississippi, September 1987
(Sheet 1 of 3)



b. Pools C and D

Figure 2. (Sheet 2 of 3)



c. Pools A and B

Figure 2. (Sheet 3 of 3)

Figure 3. A sand and gravel operation was observed in Reach 3

Figure 4. A very productive gravel bar was found in Reach 5, below the Smithville Bridge

Figure 5. An exposed gravel bar in Reach 6

Figure 6. Moderate currents, sand substratum, and lack of exposed gravel bars characterized Reach 8

APPENDIX A: STUDY SITES ON THE EAST FORK OF THE TOMBIGBEE RIVER

1. Mussels were collected in nine reaches of the East Fork of the Tombigbee River (Figure 2*). Characteristics of each reach are described below.

Reach 1: US 278 to Highway 6

2. Between the US 278 Bridge and the entrance of Town Creek, the river was wide and deep (>2 to >3 m), and the current was less than 30 cm/sec. The first exposed gravel bars were found upriver of Town Creek. Between Town Creek and Highway 6, gravel bars were long and narrow and located in river bends. The current was moderate (30 to 50 cm/sec) over the bars and usually less than 30 cm/sec adjacent to the gravel bars. Substrata consisted of sand and gravel in the bends and mud along the banks. Many shells were found in muskrat middens, and live mussels were found in runs (depth >1.0 m) and on the outside of bends where currents kept the gravel sediment free.

Reach 2: Highway 6 to Standifer Creek

3. This reach of the river was mainly pool-riffle habitat, with gravel bars in the bends and mud in depositional areas. The current was swift (>50 cm/sec) over the shoals and moderate (>25 cm/sec) in other reaches. Only a few shells were encountered, and no live mussels were found.

4. Immediately upriver of the Highway 6 Bridge, a gravel operation had used a dragline to remove gravel from the main river. Fresh shells were found in the dredged material.

Reach 3: Standifer Creek to Boguefala Creek

5. Many large gravel and sand bars were in this section of the river. The effects of gravel removal were noted at three or four of the bars (Figure 3). Many fresh shells and a few live mussels were on a gravel shoal about

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* See figures at the end of the main text.

3.2 km upstream of Standifer Creek. This was the only site in this reach where live mussels were found, although shells were common.

Reach 4: Boguefala Creek to Lock B Spillway

6. Many shells in muskrat middens and a few live mussels were found at the first gravel riffle about 2 km upriver of Boguefala Creek. Shells were found upriver of this shoal. Fine-grained sediments had settled in depositional areas. Water velocity was high (>50 cm/sec) in the bends and moderate (25 to 50 cm/sec) in the runs.

Reach 5: Lock B Spillway to Old Smithville Bridge

7. The lower section of this reach was similar to Reach 4. No live mussels were found, although shells were common on exposed gravel bars. Near river mile (RM) 278, many fresh shells were found on a large gravel bar that constricted the channel (Figure 4). Live mussels were collected on the upriver portion of the bar. Live mussels were found between this gravel bar and the Smithville Bridge. Current in the upper section of this reach was moderate (25 cm/sec), and substrata consisted of sand, gravel, and fine-grained sediments in depositional areas. With the exception of occasional deep holes, water was 1 to 2 m deep.

Reach 6: Old Smithville Bridge to Mill Creek

8. In this reach, the river was narrow, and water velocity was high (>75 cm/sec) over shoals, around gravel bars (Figure 5), and in the bends. Thick deposits of mud were often noted in depositional areas. Many mussels and fresh shells were found along the peripheries of the bars. A few mussels were found along these bars, but a significant portion of the population had recently died. Most of the recently dead individuals were adults.

Reach 7: Mill Creek to Old US 78 Bridge

9. This reach of the river was narrow, shallow, and meandering, with stable mud banks, small sandbars, and mud and sand substratum. The only

gravel bars in this reach were above the channelized section of the river (between RM 384 and 385). Small patches of gravel were often covered with recently deposited mud and sand. Subfossil shells were found on the gravel bars, but no live mussels or fresh shells were collected. Live mussels included the yellow sand shell (*Lampsilis teres*) and the Asiatic clam (*Corbicula fluminea*). The channelized portion was shallow (<0.5 m) with a clay and mud bottom. Mantachie Creek, which is channelized, appears to deposit a heavy sediment load into this reach.

Reach 8: Old US 78 Bridge to Mackeys Creek

10. This reach had well-defined narrow banks and many meanders. Substratum consisted of mud and sand, with accumulations of sand below channelized tributaries (Figure 6). Snags and natural obstructions had formed deep holes in some bends. A desnagging crew was clearing the channel. No live mussels and only a few shells were found.

Reach 9: Mackeys Creek to Lock E

11. Mackeys Creek was very narrow, well defined, meandering, with mud and sand substratum. Hard clay and rocky outcrops formed shoals in the vicinity of Lock E. Asiatic clams were common to abundant in depressions in these shoals. No live mussels or shells were collected.